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"MATHEMATICS" APPLIED TO CHEMISTRY.

Researches on the Affinity of the Elements, and on the Causes of the Chemical Similarity or Dissimilarity of Elements and Compounds. By Geoffrey Martin. Pp. xii+287. (London: J. and A. Churchill, 1905.) Price 16*s.* net.

THE word "mathematics" has been placed in the title of this review in inverted commas, because, although the mathematical formulæ employed appear to be formally correct, the application of mathematical formulæ to the data collected in Mr. Martin's work appears to the reviewer to be unjustified. To demonstrate this a sketch of Mr. Martin's scheme is necessary.

Mr. Martin's endeavour is to find for each element, and, if desired, for each compound, a formula which will express its affinity for all other elements and compounds, so that it may be possible, in his own words, "to discover the law regulating the chemical attraction the elements mutually exert on each other"; and this is achieved, according to him, by "the construction of some geometrical figure which will quantitatively pourtray the chemical properties of the element."

The plan adopted is to arrange the elements into series and columns, as in the usual periodic diagram; the group numbers are plotted along a horizontal ordinate OX, and the series numbers along an ordinate at right angles to the former, OY. There are ten points along OX, filled in the second group by the elements Li, Be, B, C, N, O, F, and Ne, and there are eleven points along the ordinate OY, occupied in the first column by the elements H, Li, Na, K, Ca, Rb, Ag, Cs, ?, ?, and Au. This, it will be seen, gives one of the common forms of the periodic table. Next, for any one element, having one definite valency (one, it may be, of several valencies which it may possess), perpendiculars are erected on the point occupied by each of the known elements, expressing by its height the affinity of that element for each of the others. Thus, choosing the element chlorine, and regarding it as monovalent, vertical lines are to be erected, showing by their length that that erected on, say, the point occupied by cæsium, expresses a high degree of affinity or attraction; the vertical on the point occupied by arsenic, for example, viewed as triad, would show by its shorter length that the affinity of chlorine for arsenic is less than it is for cæsium; a repetition of this process for all known elements produces a number of points, 10×11, or 110 in number, if all spaces are considered, or a smaller number, the number of the actually known elements, in actual practice. Mr. Martin *imagined a curved surface to be drawn through these points,* and proceeds to develop equations which will represent that surface. He shows, so far as the reviewer can see, correctly, that for the complete characteristic equation for the supposed 110 elements, each of which is supposed capable of existing in 8 degrees of valency, there are $2{\cdot}3486 \times 10^{108}$ different possibilities of associating degrees of valency! However, by a device the author mercifully lowers this number to 8448, being 64 times 132; 132 represents the number of constants for the characteristic affinity-surface for each element existing with only one of its possible eight valencies exercised.

We have italicised the words "imagined a curved surface to be drawn through these points" because there lies the crux of Mr. Martin's attempt. What reason has he to join his points? Does he imagine that the interspaces are filled by an infinity of elements of all conceivable atomic weights between the known limits 1 and 240? If not, then the whole system is discontinuous, and the characteristic surface is non-existent.

But we will accept Mr. Martin's method for the moment, and inquire how he imagines affinity to be measured, so as to obtain the lengths of his vertical coordinates. The methods of estimating comparative affinity may be taken as three in number. First, he suggests that while the "energy of combination" should be measured by the heat generated by a reaction starting from the absolute zero, such measurements are impracticable, and, *faute de mieux,* the "heats of formation" at ordinary temperatures must suffice. This method may be better realised by a concrete example. One-third of the heat evolved when boron burns in chlorine amounts to 34·7 calories; one-quarter of that of the formation of silicon chloride is 39·4 calories. These numbers are approximately equal, hence the affinities of boron and of silicon for chlorine are nearly the same. But this is not always the case; for instance, as Mr. Martin points out, $\frac{1}{4}(Si,H_4)=8{\cdot}2$, whereas $\frac{1}{4}(C,H_4)=5{\cdot}2$; yet "undoubtedly of these two bodies, the H is attracted to the C in CH_4 with a greater intensity than it is attracted to the Si in SiH_4." He therefore guards himself by the statement that "it is only when the heat evolved in the formation of a compound is very great that it can be taken as measuring approximately the attractive forces." There may be a little in this, but the reviewer has read something like it before. Second, an estimate of the relative affinity of the elements in two similar compounds may be derived from a consideration of their temperatures of decomposition. Again, that suggestion is at least a century and a half old. Third, temperatures of reaction may be made a rough measure of affinity. For instance, lead oxide is reduced by hydrogen at a lower temperature than iron oxide, hence the affinity of lead for oxygen is less than that of iron. Estimates of such affinities, and their application to the formation of curved surfaces as described, fill 206 pages of the work. Three appendices treat respectively the causes of the absence of other compounds of elements than those which contain the element at a high or at a low grade of valency; the bearing on the phenomenon of life of the critical temperature of decomposition of chemical compounds; and lastly, "the possible significance of alcohol drinking," in which the glorious hope is held out to our remote de-

scendants of a world in which, owing to a decrease in temperature below the freezing point of water, that useful liquid will be replaced by alcohol!

There is a Scots proverb running thus:—"Mickle cry and little 'oo (wool)." The amount of "wool" in this work is surely insufficient for the "cry." Yet there are some suggestive passages, and the author has evidently spent much time over his problem.

A word in conclusion as to the "get-up" of the book. The reviewer, in reading it, felt that he must act as a proof-reader. There is hardly a page on which a misprint does not occur; and such lapses as "The only data available *is* the following:"; the words *uni-* and *tetra*-valent in one line; "to completly (*sic*) picture"; and the printing of almost every sentence as a paragraph, make the reader's task an ungrateful one.

Something, no doubt, may be accomplished in course of time when affinity constants have been numerically determined (and many are already known) to show that they, too, are periodic functions of the atomic weights; but Mr. Martin has not succeeded in pointing out the lines on which this goal is to be reached.

AN ORNITHOLOGIST'S JOURNALS.

Travels of a Naturalist in Northern Europe: Norway, 1871, Archangel, 1872, Petchora, 1875. By J. A. Harvie-Brown. 2 vols. Pp. xxii+541; with coloured plates and other illustrations and 4 maps. (London: T. Fisher Unwin, 1905.) Price 3*l.* 3*s.* net.

THE journals which compose the greater part of these two handsome volumes relate to three ornithological visits paid to Norway, Archangel, and Petchora about a quarter of a century ago, and the author good-humouredly anticipates their being regarded as "stale news" or "cauld kail het again." On this score, however, there was no need for an apology, for the author tells his story for the first time (apart from previous technical reports), and, besides, the interest of a naturalist's observations depends, not on their date (provided the date be given), but on their intrinsic worth.

As Mr. Harvie-Brown is an accomplished ornithologist, an enthusiastic faunist, and the author of some delightful and valuable books on the natural history of Scotland, it goes without saying that these journals contain some interesting scientific information and some picturesque narrative. But the trouble is that to discover these oases we have to traverse what seem to us dreary deserts of trivial and commonplace monotony, and we can hardly control our impatience by remembering that there had to be many trivial and commonplace days before the author found the nesting-ground of the little stint. What is published is just what was written down at the close of each day, and it follows that items which loomed large at the moment, such as the supper menu, appear of little importance to the callous reader, as doubtless to the journalist himself in retrospect at Dunipace. He got such a gorgeous "bag" of birds—1019 skins and 1021 eggs from the Petchora hunt alone—that we can sympathise with his wish to live his hunting days on the tundra over again; we only wish that his recapitulation had not been so terribly *in extenso*. We are much interested to read how Mr. Seebohm came in one evening, "and with a triumphant thump laid on the table, first a Grey Plover, then a Snow Bunting, and then a Curlew Sandpiper; lastly, and most triumphantly—hurrah!—five Little Stints, long looked for, found at last"; but we cannot get up much enthusiasm over the bulk of the narrative.

The tour in Norway was more or less of a novelty in 1871, and much is related that is now familiar. Much has changed, but more remains the same, and one unchanging feature of which the journal affords abundant illustration is the human appetite.

The Archangel region had been but little worked by ornithologists when Mr. Harvie-Brown and (the late) Mr. E. R. Alston explored there in 1872, and they were richly rewarded. The journal becomes more interesting, though our attention is still distracted by Ernst Craemers's toothache, by the size of the packing-case for the birds, by Alston's loss of his big knife ("one made by Wilkinson, of London"), by the number of bowls of milk drunk, and so forth.

The most adventurous journey was that which Mr. Harvie-Brown and Mr. Seebohm took in 1875 to the region of the Petchora, where they were the first to find the eggs of the little stint in Europe. The author shows his powers in the graphic description of the locality and in his story of the discovery. We quote the description of the nest:—

"Rather untidy, rather rough and uneven round its rim, very shallow, sparingly lined with dry grasses and a little leaf or two, which may have been plucked by the bird as she sat in her nest. Round it, deep, spongy, but not wet, yellow moss, the dark green leaves and empty calices of the Arctic Bramble, a tuft of round-stemmed green sedge with seed; a little further off, the now flowerless plants of the sweet-scented dwarf rhododendron, and bunches and patches of long white grass and plants of a small cotton-grass, and other plants and grasses, of which we shall bring home specimens for identification."

There is a fine plate of stint's eggs, and a careful comparison of the little stint and Temminck's stint. Another beautiful plate contrasts the eggs of grey plover and golden plover.

In the course of the Petchora journal we find some notes on habits which are interesting, *e.g.* those relating to the fact that birds which do not perch, or but rarely perch, in other countries, perch in Petchora. Thus, on one occasion, by patiently following up the "tick tjuck" of the common snipe, Mr. Harvie-Brown had the satisfaction of seeing this wader "perched on the tip-top of one of the gaunt branchless blasted larches, quite 70 feet from the ground." Curlews, gulls, snow-buntings, &c., were also seen perching.

"It is, we think, undoubtedly forced upon them by the great flooding of the country, and what was originally forced upon them has become a favourite habit."